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Fire in health buildings

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Fire in health buildings

Meetings at the Scottish Hospital Centre on 6 December 1973 and 11 January 1974.

This report covers two conferences held in conjunction with an exhibition at the Centre to review different aspects of fire in relation to Health Service buildings. In opening the exhibition and the first session, Mr. Enoch Humphries, National President of the Fire Brigades Union and Member of the Western Regional Hospital Board recalled a number of recent major fires in public buildings and emphasised the considerable losses involved. He stressed the importance of training all levels of staff as to the correct procedures to be adopted in the event of a fire outbreak and for the need to provide efficient equipment for use in the prevention, detection and fighting of fire.

I

Detection and Prevention

MR R P FRASER, Secretary of the Scottish Home and Health Department and Chairman of the Council of Management of the Scottish Hospital Centre took the Chair.

Engineering aspects

MR R P TARKENTER, Engineer, Scottish Development Department noted that the regulations produced by the Institution of Electrical Engineers formed a fundamental part of electrical safety and fire prevention in buildings and were backed up by a large number of British Standard Specifications and Codes of Practice. The Buildings Standards (Scotland) 1971, which included the IEE Regulations, were mandatory in Scotland. Otherwise the Regulations carried no statutory powers and were only a guide to good practice. They did not attempt to form a specification or take account of every possible circumstance but identified areas and situations requiring special consideration with regard to safety.

Despite all the regulations and fire precautions, fires caused by electrical equipment and cables continued to rise. In 1970 of some 39,000 fires in commercial buildings, 7,500 were caused by electrical cable or equipment. In relation to hospitals, during 1968 a sample of hospital fires had shown that of 680 fires, 140 were attributed to electrical cables or equipment. A large proportion of fires were basically due to carelessness and misuse of equipment and this applied equally to portable and fixed appliances and to the correct installation and connection of equipment. It was likely that a large percentage of these was caused by high resistance joints or partly severed cables causing local overheating.

It was clear that the fire alarm installation itself must not be a contributory factor in the cause of fire and, once the fire had started, the system must remain in operation in the vicinity of the fire for as long as possible. It would help if the fire alarm cabling could be separated from the normal service runs but in a modern hospital this was not easily achieved. Service ducts were provided rising through cupboards and above false ceilings and contained heating pipes, gas pipes and cables of all descriptions. If a fire were to start in a service duct it was possible that alarm systems could be put out of action before the fire became apparant, although some measure of protection for PVC cables was possible by coating them with an intumescent paint. Mineral insulated cables were also used very frequently for fire alarm systems. These could withstand very high temperatures without failing but careful consideration had to be given on these installations to the joint boxes.

The problems of maintaining good electrical contact had been evident for many years but, with the introduction of aluminium and untinned copper cables, the difficulties were increased due to problems of oxidisation. The Electrical Research Establishment had shown that the incidence of fire increased with the age of the installation and there was evidence to show that immediate post-war installations were more prone to fire incidents than pre-war installations of the same age.

Engineers were sometimes considered to be over-cautious when seeking to carry out repairs or renewals on installations that had not given trouble and appeared to be satisfactory. Installations such as these were not uncommon and were susceptible to mechanical damage or a transient overvoltage which could lead to rapid failure. There was a danger when budgeting for maintenance funds to keep deferring rewiring schemes because of other priorities.

The fire alarm installation was the key in any fire precaution system and Hospital Technical Memorandum No. 16 indicated that the basic desirable requirements for fire alarms in hospitals were that no occupant should have to walk more than 100 ft to reach a call point and audible warning should be given to a central control and other appropriate locations with visual indication of the location of the fire call. Also facilities should be provided at the control station for passing fire alarm calls to the Fire Brigade and initiating the alarm procedure. Automatic relaying of the call to the Fire Brigade was desirable and automatic circuit fault indication with audible warning and supply failure alarms together with simple test facilities should be provided.

The alarm call points might be of the break-glass or key operated types or the internal telephone system might be used providing certain requirements were met. Arguments could be put for each system and if the telephone system was used, a significant cost saving could be shown.

Conventional systems could be grouped under broad headings of open circuit or closed circuit. Both systems could be monitored and a warning given in case of circuit failure. The normal practice was to sub-divide the system into a number of clearly defined zones,

their size depending on the general nature and layout of the building. Most hospital buildings fell into the multi-zone category with each zone forming a separate fire compartment. For the small to medium sized installation, the standard break-glass contact, bell and indication board system perhaps backed up by some form of automatic detection equipment and magnetic door switches would be acceptable. But with regard to the large hospital complex it was not unusual to find a central communication control system and some form of supervisory and control centre for boiler plant, heating, refrigeration, ventilation and medical gases. The next logical step was to combine the fire alarm system with this central control, thus allowing all the engineering services to be monitored from one position. Computer controlled equipment was also now available for installation in fire stations that could hold in its memory bank complete floor layouts showing escape routes, positions of smoke stop doors, hose reels etc. and any other relevant information about the building, occupation or contents.

For most fires the largest hazard to life came from the smoke and fumes produced. Although an air conditioning or ventilating system might be a potential means of spreading fire and smoke, conversely the design of a system could be such that it might be used beneficially to control smoke from fires. Where it was required to prevent the spread of fire through a compartment wall, floor or protected shaft, fire dampers operated by fusible links or other sensing devices could be installed. In common with other safety equipment, however, fire dampers had to remain effective after many years often in inaccessible places and in conditions not conducive to ease of maintenance.

Fire protection in relation to ventilating and pressurising large covered areas.

MR W BLACKWOOD, Consulting Engineer, Ian Hunter and Partners, spoke on the control of smoke and toxic gases produced by the combustion of materials and methods of avoiding the spread of these gases into escape routes such as corridors, lobbies, stairwells, etc.

Smoke logging, as it was termed, could take place very rapidly and produce serious problems in regard to hindering escape, endangering lives and restricting and possibly even preventing fire fighting. Hospital buildings presented very special problems. The development of district general and teaching hospitals did, by their nature, greatly magnify the difficulties and no clear picture had emerged as to how buildings should be designed in relation to smoke control. The principle of pressurising stairwells and lift lobbies was already well established and there were a number of buildings in the UK where installations had been tested. Since the results suggested that an efficient answer had been found, it was possible that this idea could be applied to hospital corridors.

The four main influences on air movement within a building were (1) stack effect (2) wind (3) fire and (4) mechanical ventilation.

(1) Stack effect - since air density lessened with temperature increase, the temperature difference, in winter particularly, between inside and out produced air movement within the buildings, principally in vertical shafts, ie lifts and stairwells. The direction of air movement might well be contrary to that required and therefore the design must take this into account. Stack effect was particularly important on high buildings whereas corridors were relatively insensitive to it but were more affected by wind.

(2) Wind - the pressure distribution on the face of a building depended on many factors; topography, direction of wind, shape and height of buildings. Prediction of the effect on the building could be made more accurately using models and increasingly this was being done on larger developments. The result of this pressure could be to produce internal air movement horizontally and also vertically. Generally for buildings higher than 90 metres, wind might be ignored except where stairwells were divided into 8 storey sections.

(3) Fire produced rapid temperature and pressure increases to the air in the vicinity of the outbreak. These in turn caused smoke to emit from the top gap of a door while cool air entered the room via the bottom gap.

(4) Mechanical ventilation - the effect that the mechanical ventilation could have on internal air movement was well known. Systems could however produce equitable conditions to work and live in and the current practice of supplying more air than was exhausted assisted in limiting the effect of wind and stack.

To pressurise a particular zone in a building to a specified level by means of mechanical ventilation, the rate of air input was determined by the resistance of the leakage paths, ie door and window gaps, building joints, etc. A pressurisation system therefore relied on proper control of the fit of these building elements particularly during construction.

Since the fresh air supplied for pressurising must be vented to maintain internal air movement patterns, exhaust vents must be included in the design. Methods of venting included window leakage, mechanical and natural vent systems. All required careful consideration since weather stripped doors could provide insufficient crackage on their own. Where a ducted system was employed, heat and smoke dampers usually fitted at fire boundaries must be omitted lest they isolated the vented area; this arrangement was contrary to present regulations.

In conclusion Mr Blackwood considered that more research was required before clearly defined design procedures could be drawn up. Ideally since mechanical ventilation was required in many internal areas in any event including corridors, lift lobbies etc. it was extremely tempting to employ that same system for pressurisation. Suggestions as to reducing the pressure levels during every-day operations already existed. However, plant reliability, stand-by and emergency considerations, operating schedules, hardware limitations, additional air isolating features (for accommodation) and control aspects needed to be taken into account but it was likely that very shortly an economic and practical solution to these difficulties would be found and the pressurisation and environmental system would be combined in many instances.

Equipment

MR I MACDONALD, Scottish Area Sales Manager, AFA-Minerva Ltd, gave a description of the range of equipment available for use in fire prevention and detection and which was currently on display at an exhibition at the Scottish Hospital Centre. He discussed briefly the problems associated with fire prevention and stressed the importance of training staff in good housekeeping and safety requirements regarding the location of flammable liquids. The history of detection techniques was traced concerning heat, smoke, combustion gas (ionization), infra red and ultra violet detection.

Ancillary equipment associated with detection was explained covering magnetic door release units, manual break-glass units and audible and visual warning devices. Standards required to obtain a satisfactory and trouble-free system with respect to equipment and electric wiring were of considerable importance and, in relation to engineering, parameters were mentioned which included comment on the limitations of each type of detector and the problems associated with incorrect siting. Fire brigade communications were outlined giving the systems available, ie Home Office Signalling; VF System A; Central station signalling (Commercial); 999 Telephone Alarm and Satellite Signalling System (proposed)

Comprehensive fire precautions - obligations of occupiers

MR A TAIT, Senior Fire Prevention Officer, South-Eastern Fire Brigade, noted that the Fire Precautions Act, 1971, had been brought in to make further provision for the protection of persons from fire risks and for related purposes. Section 1 listed classes of use for which a Fire Certificate was compulsory:-

1 for any purpose involving the provision of sleeping accommodation

2 as or as part of an institution providing treatment or care

3 for purposes of entertainment, recreation or instruction or for purposes of any club, society or association

4 for purposes of teaching, training or research

5 for any purposes involving access to the premises by members of the public whether by payment or otherwise.

To date only one Designating Order - the Fire Precautions Hotel and Boarding Houses (Scotland) Order 1972 - had been made. The proprietors of hotels and boarding houses which came within the scope of the Order had to make application to the Fire Authority for a Fire Certificate. The application was made on the appropriate form and the relevant property had to be visited by the appropriate officer appointed by the Fire Authority who after full assessment of the situation would then issue a Fire Certificate. In making this assessment the Authority had to be satisfied with:-

(a) the means of escape in case of fire with which the premises were provided

(b) the means, other than the means for fighting fire, which was provided for securing that the means of escape could be safely and effectively used at all material times

(c) the means for fighting fire, whether in the premises or affecting the means of escape, for use in case of fire by persons in the building and

(d) the means for giving to persons in the premises warning in case of fire were such as might reasonably be required in the circumstances.

Where the Authority were not so satisfied, they were required to serve a notice on the applicant informing him of the steps which would have to be taken to satisfy the requirements. The Fire Authority must also consult the appropriate Building Authority if structural alterations were to be carried out. Although no policy had yet been laid down with regard to hospitals it was likely that a similar procedure initially would be adopted. Hospitals being Crown property however, the application would require to be sent to H M Fire Inspectorate although some responsibility in the matter could be delegated to the appropriate Fire Authority.

The contents of a Fire Certificate were specified in the Act which stipulated that every Certificate issued with respect of any premises should specify:-

(a) the particular use, or uses, of the premises which the Certificate covered

(b) the means of escape in case of fire

(c) the means, other than those for fighting fire, for securing that the means of escape could be safely and effectively used at all material times

(d) the type, number and location of the means for fighting fire whether in the premises or affecting the means of escape for use in case of fire by persons in the building

(e) the type, number and location of the means for giving to persons in the premises warning in case of fire.

The Fire Inspectorate or Fire Authority might, however, impose any requirement which was considered appropriate in the circumstances. For instance (a) for securing that the means of escape in case of fire were properly maintained and kept free from obstruction (b) for securing that the means were properly maintained (c) for securing that persons employed to work in the premises received appropriate instruction or training in what to do in case of fire and that records were kept of instruction or training given for that purpose (d) for limiting the number of persons who might be in the premises at any one time and (e) as to other precautions to be observed in relation to the risk in case of fire to persons in the premises.

Considerable thought had been given to the standard type of certificate and many Authorities had produced their own version on approximately the same lines as the certificate issued by the Home Office. Although it was uncertain whether this form of Certificate would be used for hospital premises when they were designated, it might be that a similar document would be devised.

II

Evacuation and Design

MR E W M WATT, Secretary of the Board of Management for Inverness Hospitals and Member of the Council of Management of the Scottish Hospital Centre took the Chair.

MR T D W ASTORGA, Regional Architect, Western Regional Hospital Board, noted that in hospital developments it was necessary to design and construct buildings to minimise the spread of fire and to facilitate the movement of people to places of safety should a fire occur. Protection against fire was of the highest importance and must be considered at the earliest possible stages of design so that requirements could be embodied in the scheme from the outset.

There was a considerable amount of guidance material, together with various Acts and Regulations to which the building plan must conform. These included the Scottish Building Regulations, Offices, Shops and Railway Premises Act and Design Note No 2 issued by DHSS together with various Hospital Technical Memoranda including in particular No. 16. In addition the advice of Firemasters through their Fire Prevention Officer must be sought concerning means of escape and other fire precautionary measures required within the building.

Hospital Design Note No 2 - "Protection against fire" - made an examination of the hazards of fires in hospital buildings and recommended particular techniques to deal with them particularly in relation to compartmentation. This meant the physical division of the building in to fire-tight compartments enabling the evacuation of staff and patients to be phased in the case of an emergency. The first phase would be the movement of patients and staff from the compartment in which the fire originated into an adjacent compartment allowing the fire affected area to be sealed off. Only if the fire outbreak could not be brought under control within the compartment in which it originated would the second stage of escape by way of the staircases to another compartment, be necessary.

The third phase would be the evacuation of the building and the moving of people outwith the structure. Should stages 2 and 3 become necessary, the gain in time due to the existence of compartments would reduce the urgency with which these more difficult stages need be undertaken. If the Fire Brigade was called promptly and the compartment in which the fire originated was quickly evacuated and closed, the second phase of evacuation might not be necessary. In planning, therefore, emphasis must be laid on ensuring that the first stage of evacuation could always be carried out effectively and safely and the remaining stages could be achieved if essential to do so.

Design Note No. 2 did not replace the Scottish Building Regulations, although, in general, the demands laid down in the Design Notes were actually higher than required by the Regulations. The Note divided hospital into four main categories in relation to compartments and sub-compartments:-

(a) areas of high fire risk or high fire load included laboratories, main kitchens, laundries, boiler houses, works departments and main stores.

(b) areas of high life risk, eg wards, must form separate compartments over all other parts of the building. Wards should be planned so that all staff and patients within a ward compartment were able to move horizontally over compartments or sub-compartments using the staircases to escape to the open air if absolutely necessary.

(c) remaining parts of the hospital only required compartmentation over 15,000 sq ft.

(d) communication areas - it was essential to keep the stairways passable in order to facilitate Fire Brigade access during an outbreak of fire and to provide vertical means of escape for patients and staff from the building; and as lifts could not be relied upon as a means of evacuation in case of fire, staircases must form separate compartments in order to prevent fire and smoke from entering.

No multi-storey hospital should have less than two staircases and at no time must the escape route to staircases exceed 100 ft in distance in one, two or more directions, and the maximum travel distance from a dead-end to a staircase must not exceed 40 ft. It was therefore advisable to have staircases at the end of blocks but, where this was not possible, only ambulant patients should be accommodated in "dead-end" areas.

Two points highlighted in the Scottish Building Regulations concerning staircases were vital to note - Regulation 50 stated that staircases should be separated from the remainder of the building by a fire-division wall and No. 51 stated that where the building height was more than 80 ft the stairs should have a lobby access, the lobby to be naturally vented to the open air. All lobbies and landings should be adjacent for easy handling of patients on stretchers or on mattresses, and in all cases stairs should discharge at ground level directly to the open air, or into separate compartments, or to the open air via a protected corridor. A staircase should never continue straight down to the basement as it could cause a grave risk to life where visibility might be impaired due to smoke and patients and staff escaping via the staircase could enter an area of no escape and be trapped.

Lifts wherever possible should be grouped in such a way that the lift system formed a separate fire resistant enclosure, protected at each floor level with fire check doors to all lift openings. Service ducts formed a possible path whereby fire might spread from one compartment to another and consequently it was essential to ensure that they were compartmented and all access doors to ducts within the building should be tight fitting. Roof voids must also be carefully considered and where ceilings did not have adequate fire resistance, walls from the compartment must be carried up through any roof void and any openings in these walls should be fitted with doors of adequate fire resistance.

Foul linen or refuse chutes must be adequately enclosed, impervious and incombustible and the doors to the hoppers at various levels should be fire resistant and form an effective smoke stop.

Doors in a hospital could be a very controversial factor as their enforced closure and positioning often conflicted with nursing and medical functions of a ward or department. However, in areas of high fire risk and in fire division walls, doors (fire resistant) should have the same rating as the wall in which they were contained. In sub-compartment walls in areas of high life risk the doors (fire check) need only have half the fire resistance of the wall or 30 minutes, whichever was the greater. Doors to staircases at all times should remain shut and should never be fitted with ironmongery to allow them to be held open. This could not be over-stressed and reports have often indicated the improper use of fire resistant doors in hospitals sometimes being propped open when they should be kept closed at all times.

Advice contained in the British Standards Specification 476 had also to be considered. This laid down the various categories of flame spread of materials which were vital in relation to materials intended for use as internal linings and finishes in a building. Those involved in alterations and works of upgrading or in the redecorations of buildings must satisfy themselves that a fire risk situation was not being created by a failure to understand the performance of materials and decorative finishes.

Naturally many existing buildings were bound to give some cause for concern and, while Firemasters' reports highlighted deficiencies, like every other head of expenditure, only a limited amount of money could be allocated to improving fire precautionary standards within the building and engineering programmes in any financial year.

When the Fire Precautions Act 1971 became mandatory for hospitals and other health buildings, HM Inspectorate would state the precise standards required in both existing and new developments in order to receive a Fire Certificate. Perhaps the day was not far away when the implementation of the Act would cause authorities to re-assess the cost of bringing their buildings up to an even higher standard than at present.

The nurses' viewpoint

MRS M G MALTMAN, Matron, Southfield Hospital, Edinburgh and MR M H DALTON, Chief Nursing Officer, Royal Cornhill & Associated Hospitals, Aberdeen, spoke on the nurses' problems in the event of fire. The greatest difficulty facing nurses in this situation was just how well prepared they were to deal with the emergency. During the months subsequent to the Coldharbour fire disaster, hospital staff were alerted to fire hazards and many hours of duty time throughout the Service were devoted to informal question/answer sessions, lectures, films, demonstrations and exercises. Although the number of fires was increasing at the rate of 10% annually, fires in all hospitals averaged out at two each day and in the years 1963/67 an average of one patient died every eight weeks as a result of fire in hospitals. With such relatively small figures, many nursing staff would never be involved with a fire and it was consequently a problem for nurse managers to keep clinical staff

aware of their responsibility for fire prevention and of their duties in the event of fire. It was the case that it often required a crisis to ensure that action was taken upon a subject which all concerned would agree should have received attention without such an impetus. The Report following the Sheldon Hospital fire in 1968 highlighted that none of the permanent night staff had received any fire procedure training over a period of many years. By contrast the Coldharbour enquiry revealed that fire drills were adequate for the staff as a whole although they did recommend more drills for the night staff.

There was a need in hospitals for professional firemen who could teach fire prevention, fire evacuation techniques and elementary fire fighting procedures. A fire safety officer who could work flexible hours visiting staff in their working situations, to assess standards of fire safety was required and who would instruct senior staff and key personnel. Such an officer required a lively enquiring mind to investigate new developments and a personality whereby his comments would be taken as helpful and be adopted.

Senior nursing staff must of course teach ward nurses what was required of them in the event of fire. The nursing administrators would obtain their knowledge from the fire safety officer and could use him as a consultant for related problems. With this information regarding skills and techniques, regular fire drills and evacuation exercises could be initiated. The frequency should depend upon such factors as staff changes, variation in ward topography, differences in patient mobility and degrees of dependence and location within the hospital. The fire safety officer could also initiate his own exercises to check that the agreed standards had been achieved and were being maintained.

Releasing staff, particularly those on night duty, for fire instruction was a problem and one which could be met by staff being taken in small groups during an extended meal break. Such occasions could make the teaching of fire safety personal and properly handled, could eliminate individual misunderstandings which could occur in large meetings. For many night staff due to domestic commitment, study days were impractical but with a little ingenuity study nights could be arranged for larger groups and could feature fire safety.

The Coldharbour report stated that where high risk fires were to be accepted as unavoidable there should be compensatory factors such as extra staff or selected patients. One compensatory factor was that staff in high risk areas should attain an equally high standard of fire safety. To bring all ward staff in hospital to the same high degree of fire consciousness was however as unrealistic as making every ward and department fire-proof.

The Committee of Enquiry in 1972 considered the nurse staff situation at night and recommended the establishment be increased by 40%. By contrast in many psychiatric hospitals it was frequently therapeutic policy to minimise staffing to a level where patients drew up their own resources and avoided institutionalisation. Therein lay a conflict in how predictable was the behaviour of people about whom there was an element of uncertainty. Continual assessment based on good observation was vital if risks were to be minimised but no matter how

critical the assessment an element of risk was still to be borne. Self-care accommodation should be fitted with smoke sensory units which could warn the occupants and staff elsewhere in the event of fire. Like so many other things however, they were on a list competing for the limited finance available.

Although there was little problem in relation to young nurses on night duty since their experience was limited by the GNC and they worked under the supervision of qualified nurses, problems usually related to staff recruited directly to night duty without previous training or experience. In this connection, induction courses were helpful but supervision was required until they appeared competent and felt confident. Shortage of staff frequently left nurses working alone when ideally they should still be under supervision, but it was to the credit of senior nursing staff that they allocated staff as well as they did in trying conditions. A similar problem lay in the number of staff who gravitated to night duty for personal or domestic reasons which could reduce their efficiency. Although hospitals frequently stated a minimum number of nights for which part-time staff would be accepted, it was probably better to accept the administrative inconvenience of staff working one night weekly and know they were dependable than insist upon a three night minimum and the employment of over-committed night staff. Supervision became all-important and the maintenance of a high standard was dependent upon good personnel management.

It had been recommended that the night nurse should be provided with a duty room. The room with a sliding glass viewing panel would overlook the dormitory enabling the nurse to survey the ward and would include a telephone and facilities for light refreshment. Such rooms however, brought a false sense of security to the staff concerned since uninterrupted observation from any one point was now seldom possible due to compartmentation of ward units. By preference a portable night station in the form of a small desk table was all that was likely to be required. Comment had also been made that many doors were kept locked and it had been suggested that this was only really necessary where there were dangerous patients and to a lesser extent for wandering patients. Security officers should however, be concerned about the risks of pilfering and recommend that outer doors and windows should be locked at night. Allied to this was another problem highlighted in the Coldharbour report, the non-repair of buildings and equipment. Building supervisors and hospital engineers must give attention when delayed action followed a request for repairs by nurses. A simple system of acknowledgement to requests for repairs should be devised giving the reasons why repairs could not be executed within a short period with follow-up contact made at frequent intervals. Such a system helped mutual understanding and minimised risks.

Slowed reactions by patients, especially at night due to the use of sedatives, was also a problem. No doubt all drugs were prescribed from need but it could be challenged whether they were always reviewed critically and at regular intervals. Nurses should be more prepared to suggest that drugs be reduced for certain patients rather than only reporting those patients whose behaviour was different or disruptive and recommending sedation. Approved experimentation reducing drugs could lead to more active nights in some wards but, with revised patterns of patient care, it was often possible with nurse and doctor co-operating to minimise sedatives and still have patients sleep at night.

Problems were also created by the increasing number of psycho-geriatric patients being admitted to wards badly located and often ill equipped for their care and, since the installation of lifts to provide additional beds for the elderly in multi-storey buildings could lead to difficulties, a plea was made where practicable for more beds for the elderly to be made available at ground level.

The Fire Service view on evacuation and design

DIVISIONAL OFFICER T MILLER, Senior Fire Prevention Officer, Glasgow Fire Brigade, noted that recent fires in high rise buildings had indicated that present building concepts were not adequate. Only if ground floor buildings were to be provided would the problems of evacuation be eased to some extent. It was necessary to design, construct and occupy hospitals in such a way as to (1) reduce the possibility of a fire occurring at all (2) limit the spread of fire to a minimum and (3) make easy the movement of people to places of safety in the event of fire. A place of safety might in the first instance be a horizontal direction but, since total evacuation might become necessary, it could mean evacuation downwards. It was necessary to make use of compartmentation in order to separate high risk fire areas from ward areas, to divide up large areas into smaller units and to separate stairs and corridors forming escape routes from the remainder of the building. Adequate means of escape by stairs, ramps, open bridges and lifts should also be available and ventilation should be provided to extract as quickly as possible smoke and hot gases.

Layout

It was a first principle of every Fire Officer that highly flammable substances, high fire risk processes and high fire load areas should be kept as far away from stairs, corridors and exits as possible so that should a fire occur, persons were moving away from risk areas in making their escape. It was doubtful how often this principle was recognised in designing and occupying hospitals. Kitchens, records departments, shops, plant rooms, X-ray rooms, etc. were usually to be found on the basement, ground and in some cases first floors, with wards on the upper floors above. To obviate the risk of fire affecting an entire hospital, such areas should be on the top floors.

Should a fire occur in any of these risk areas, total evacuation of the wards above because of smoke logging became a distinct possibility and a very difficult task. It meant that evacuation had to be carried out down past the areas on fire, that rescuers must fight their way through fire areas to help with the evacuation and that evacuation must be carried out fast without undue heed to the nature of a persons incapacity. If the wards were beneath however, evacuation might not be necessary at all and, even if it was, it could be carried out in a more leisurely fashion with less upset to the patient and with a lesser distance to travel to ground level and safety.

Separate Buildings

Where extreme precautions were desirable consideration should be given to using several spatially separated buildings. Escape stairs could be constructed as separate units linked to the main building at each storey by ventilated or open bridges. Clearing a conventional hospital of bedfast patients in the event of fire was a time-consuming job because descent to the ground floor meant using either lifts, ramps or stairs. If a hospital were to consist of not one but several buildings joined at each level by open or ventilated bridges, no patient would have to change levels to be transferred from one building to another.

Stairs

Some sense of false security had been generated by the protection being built into the construction of stairs. Such features as lobby approaches, ventilated lobbies and fire resisting or fire check doors in practice did not provide total immunity from smoke. In order to function at all, doors must have gaps around them. All too often self-closing doors were held open by a wedge, self-closing devices became weak or faulty and did not properly close the door and doors had to be opened to allow persons to escape and permit firemen access. Wherever an opening occurred, however small or for however short a period, smoke would penetrate with frightening rapidity. Escape stairs should be constructed as separate units linked by ventilated bridges and it was desirable that further research should be carried out into the use of pressurisation of stairs as a method of preventing the entry of smoke.

Compartmentation

The success of compartmentation depended on the doors that were built into separating walls. Such self-closing doors must be maintained in the closed position or at least be fitted with electro-magnetic catches linked to smoke detectors if they were to be kept open. It was likely that this requirement would be written into the Building Regulations in the future.

Combustible materials

Although fire resisting construction was relied on, the problem of combustible contents in a building had not been solved. It was necessary to reduce to a minimum the amount of combustible materials introduced into buildings and to make sure that wall and ceiling linings were non-combustible in corridors, stairs, exit routes and wards and that they were of at least a Class I Surface spread of flame rating as defined in BS 476 in other sections of a hospital. In addition although the use of cellular plastics such as foamed polyurethane had many advantages as an insulating material and for bedding purposes, because of the large quantities of toxic fumes produced, substitutes, which were less dangerous, should be used wherever possible.

Lifts

Lifts were not designed as a safe means of evacuation and to date were not accepted by Fire Services as such. They were, however, used by Fire Service personnel during a fire and indeed it was often insisted that one at least was fitted with over-riding controls so that access to the scene of the fire could be achieved as easily as possible. It was a fact that lifts were a prime means of moving people between floors in high rise buildings and it was for consideration, if stair towers could be made smoke proof, why could not lift shafts. If total evacuation of a hospital became necessary it would be necessary to use every means of escape available.

Ramps

It was desirable that greater emphasis should be placed on the provision of ramps from the upper floors of hospitals although it was appreciated that there were design and structural problems involved. They should however, be considered as a means of getting non-ambulant patients down to ground level.

Fire alarms

If limited or total evacuation was to be carried out, there must be some means of giving warning to staff that a fire had broken out. It had been recommended that the use of telephones for this purpose should be used but this was not satisfactory. In offices, shops, factories and public buildings the glass fronted box was becoming more acceptable and was instantaneous in operation. In high fire risk areas and unoccupied parts of hospital automatic alarms should also be installed, preferably of the smoke detector type.

Access

In the modern concept of some hospitals ancillary units were spread out at ground level over a large area with the ward blocks rising up as a central core. In these circumstances the access for fire appliances was generally restricted to the perimeter. This might mean that, in the event of a fire, firemen must travel comparatively long distances to reach the source or carry out evacuation. If the fireman was to perform successful rescue operations or fire fighting duties, it was important that his energies were conserved for the essential work and not dissipated on unnecessary effort in reaching the fire. It therefore seemed obvious that it was advantageous to provide access for fire appliances as close to the high life risk areas as possible. Turntable ladders and hydraulic platforms were essential parts of the Fire Brigade's equipment and it was essential that the opportunity and facilities for using them should be given.

Training

It was essential that hospital staff should be trained in the action to take in the event of fire. This should cover senior to junior staff since it was important that everyone responsible knew exactly what was to be done in the event of fire before it took place. HTM 16 stated that "at conspicuous positions in all parts of hospital

buildings printed notices should be exhibited stating in concise terms the main essentials of the action to be taken upon discovering a fire and on hearing the alarm." It was essential however, that notices must not only be in conspicuous places but easily read. This equally applied to directional signs and route indicators both inside and outside the buildings.

There were many other features of design that had a bearing on evacuation:-

(1) there must be facilities for controlling plant and services easily and quickly

(2) there was a need for fire dampers in ducts which passed through fire division walls

(3) it was essential to ensure that all openings in walls around pipework, ducts and electrical services were efficiently sealed to prevent the passage of smoke

(4) there was a need for emergency lighting and this might be included in the Buildings Regulations in the near future.

(5) it was necessary for some methods of communication to be available between floors and ground level in high rise buildings and

(6) there was a need for good housekeeping practices to be adopted in all parts of hospitals.

The effect of fire precautions on design

MR J BEVERIDGE, Architect, Sir Basil Spence, Glover & Ferguson indicated that, although there was in existance a considerable amount of legislation controlling the design of buildings including hospitals, it was difficult to generalise about the effects of fire precautions on design. So much depended on the brief, the site and the design solution being sought. If the requirements of the fire precautions were borne in mind during the early stages of the design process in common with other planning requirements such as noise control, then the problem was simplified. Difficulties often did arise when the requirements were overlooked until an advanced stage in the design thinking had been reached.

When fire broke out in a building the immediate hazard was to the occupants. The degree of hazard to which they were exposed was largely influenced by how quickly the fire took hold which was in turn dependent on the materials used in the internal finishes and furnishings. The first essential therefore in the design and construction of the building was to ensure that the occupants could be got to a place of safety and to achieve this two main facts must be observed. Firstly adequate means of escape must be provided from all parts of the building and secondly the building must be so designed and constructed that the risk of smoke and fire spread was minimised.

The requirements for fire resistance of an external wall and extent of openings permitted in it depended on its position relative to the boundary. When fire developed within a building, heat was transmitted to other buildings in the immediate vicinity. Transmission could be by conduction through solid materials, or by convection, radiation or flying brands. As a design guide it was useful to consider the function that external walls should perform in the event of fire. The wall should confine fire within the building until it was controlled or had burnt itself out and should provide protection for fire fighting purposes. It should prevent entry of fire from an adjacent building and also prevent spread of fire from one storey to another. When positioning a building on a confined site it might be necessary to provide division walls and compartment floors with the sole purpose of reducing the area of elevation which in the event of fire might be assumed to be radiating heat. The smaller the division or compartment the nearer the building could be located to the boundary. Recommendations for protection against fire spread from one storey to another were given in Hospital Design Note No 2.

The regulation did not require resistance to a fire within the building in the design of the roof construction. Control was, however, exercised over roof construction as far as external exposure was concerned, ie where the roof was subjected to radiated or convected heat or from flying burning brands from a fire in an adjacent building. The roof construction as a whole should be capable of resisting the penetration of fire into the building for a limited period. As a general rule fire protection measures for the roof should be taken with a view to ensuring that materials used in construction should contribute as little as possible to the general spread of fire both internally and externally.

Provision must be made when siting the building and in the design of site layout to give adequate facilities for fire service access. The principal operational purposes of the fire services with which the regulations were concerned were firstly to extinguish fires in buildings quickly and secondly the rescue of people who might be cut off by fire or smoke or otherwise prevented from using all normal escape routes. Access must also be provided for in any enclosure fencing. In addition to the site access, facilities access also had to be provided to the interior of the building particularly where it was impossible to fight the fire from outside. The regulations went a long way in making provision for protected access to upper floors by the requirements for staircase enclosures and ventilated lobbies which cut off the stairway from the remainder of the floor.

The internal planning of the building was to some degree influenced by requirements for compartmentation and provision of escape stairways related to the travel distance requirements within these compartments. Compartmentation provided the basic means of fire protection whereby within the building any outbreak of fire which occurred could be isolated. In some types of buildings, however, compartmentation requirements could create internal planning problems although this was less of a problem in a hospital where functional planning requirements tended to dictate that the space was sub-divided into a number of smaller units. Sometimes conflicts did arise however, between fire requirements for escape doors and security requirements within the hospital. The area of each compartment was limited by regulations.

Hospital Design Note 2 recommended that the area was restricted to a maximum of 15,000 sq ft but, because of the nature and risk in hospitals, a further breakdown into sub-compartments was recommended. These sub-compartments were considered to function in a similar manner to the main compartment. If the compartmentation was constructed to the regulation requirements it was unlikely that fire would spread rapidly into an adjoining compartment or sub-compartment. It might be assumed, therefore, that once a person had passed through a protected opening in a fire division wall he was in a place of safety always providing that if the situation worsened it was possible to get to the second stage escape route, staircase, and eventually to the open air. The planning and design of the escape route was also very important and, once the line of escape had been defined, the exit width had to be calculated.

In hospitals the design of escape stairs was extremely important. These must be designed to permit unhampered passage of stretcher-borne patients and adequate space must be allowed for turning especially on landings. The stairway must always be enclosed and form a separate compartment in order to prevent spread of fire or smoke into the stair. The flights should be separated by landings and the length of landing should not be less than the width of the staircase. The staircase must also change direction of flights at each landing.

In relation to lifts the plan arrangement should be such that the lift system formed a separate fire resistant enclosure with the openings protected at each level with fire check doors. In multi-storey buildings of more than five storeys at least one fire lift should be provided.

Fire could spread within a building through service ducts. The regulations require that they should be compartmented and should be of a fire resisting construction with a grade at least equivalent to that of the structural elements bounding the duct. Access doors and panels to ducts must also be similarly protected.

Too often door assemblies were under-rated in importance in the fire protection of buildings. A door assembly capable of maintaining its integrity for 20 minutes and being free from collapse during a fire resistance test of 30 minutes, could be considered to have achieved the highest fire check standard. The design of the door frame and selection of ironmongery, including type of door closer was something which also required careful consideration.

In relation to suspended ceilings these could be used for a variety of purposes some functional, eg acoustics, lighting, concealing services, or could be purely decorative. From a fire protection aspect only two types had to be considered - those that provided part of the fire resistance of the structural floor or its supporting members and those that provided no protection at all. Whatever type was used the capacity of the compartment should be calculated to extend to the structural slab and not to the suspended ceiling. Suspended ceilings which did not contribute to the fire protection must not add to the fire hazard and in the design of ceilings of this type the aim should be to reduce the combustible content of the ceiling void to a minimum.

It was important to emphasise that elements of construction which had been designed for fire protection purposes should be properly carried out to the design details. The architect might specify a particular material or constructional detail on the basis of a manufacturer's fire test results. If these items were not installed as supplied to the manufacturer's instructions or as detailed and some site modification was made, this could lower the fire resistance. This particularly affected partitions, suspended ceilings, door assemblies and glazed screens which were all readily susceptible to on-site modifications and the only answer was careful site supervision and a full appreciation and understanding of the aims of fire protection. The Building Regulations did not cover all the circumstances which were likely to arise but, if one kept in mind the spirit of the regulations and applied the basic requirements in a common sense way, a satisfactory answer could normally be found. One problem however, which was not covered by the regulations was the large building complex. In the design of some of the more recent hospital developments in Scotland the concept of a large podium area at ground floor and basement levels with tower blocks rising above had been introduced. Developments of this nature were entirely outwith the scope of the present Building Regulations and tended to present a new set of problems with regard to fire protection, fire fighting and means of escape. At the present time in Scotland these large complexes were dealt with by means of relaxations but further legislation would have to be introduced to deal with such developments.

MR D JACK, Engineer, Donald Smith, Seymour & Rooley, mentioned that due mainly to the increase in size and complexity of buildings, increased sophistication of services and awareness of fire hazards, engineering services installations associated with fire at present represented a considerable percentage of the overall installation and a considerable financial commitment.

The problems faced by the services engineer could be grouped under 4 headings - (1) prevention of fire; (2) detection and indication of presence of fire; (3) provision of protected areas and (4) provision of engineering systems to assist fire fighting.

(1) Prevention of fire

The main danger from fire lay not in the flame or heat but in the toxic fumes or smoke generated from the material which was heated. Engineering installations were constructed from a wide variety of materials and, particularly in the field of thermal and acoustic installation, foamed polystyrene, polyurethane and rubber compounds, cork sheets and hair felt had been found to be the most efficient and most economic materials. In addition large quantities of PVC sheet were used to construct duct work, to handle corrosive gases and to provide moisture-proof cladding to air conditioning ducts and pipe work. However, since these materials generated large quantities of toxic gases and smoke when burnt or smouldered, it had become necessary to abandon them and substitute mineral wool fibreglass mattress and boards which were quite effective for insulating purposes. Problems did remain, however, with respect to deep freeze and cold storage rooms and temperature control rooms.

(2) Detection of fire

A considerable diversity of opinion existed as to where fire detectors should be fitted, although it was generally accepted that areas, which were not occupied for 24 hours per day, or wards where supervision was not continuous should have such detectors. Many would argue that detectors were not necessary in circulating areas and corridors but Fire Prevention Officers frequently sought to locate them in these situations. When fitting automatic detectors it was normal practice to arrange the building complex into a number of areas each area divided into specific zones. At the Fire Brigade entrance point to each area an annunciator board was fitted indicating the zone in which fire was present and an alarm was given to a central point from where the Brigade might be informed.

(3) Provision of protected areas

Relating to the compartmentation of buildings, while the service engineer could have little or no influence in the definition of the compartments, he must be closely involved with the architect at this stage of planning. The services installations should be designed to reduce as far as possible any penetration of compartment division walls. In mechanically ventilated buildings every effort should be made to ensure that the ventilation system was self contained within a particular compartment. However, main distribution ducts must necessarily pass from one compartment to another and the system should be arranged so that breaches in fire division walls were kept to a minimum. Where pipes or ducts passed through fire walls or floors it was necessary to provide barriers to fire and smoke, these barriers taking the form either of seals around pipes and ducts or dampers in ventilation ducts. It was essential that space around all pipes passing through floor or fire division wall should be plugged.

(4) Provision of engineering systems to assist fire fighting

Included in the building service installations were items specifically provided to assist with fire fighting the most important being (1) pressurised water distribution systems (2) automatic detection, alarm and plant control systems (3) fire lifts and (4) pressure ventilated staircases.

Water distribution systems for fire fighting might be hose reel type, dry riser or wet riser types or sprinklers. A dry riser system was essentially a pipe rising through the building with an inlet connection at the base to receive the Fire Brigade pumps. Outlet valves were provided at each floor to receive hoses and allowing for a speedy provision of water to any level. The wet riser system consisted of a water storage tank of not less than 10,000 gallons capacity with a pressurised ring main supplying wet risers to landing valves at each staircase landing and at various points throughout the building. The pressurising unit consisted of an electrically driven pump, diesel engine pump, pressure tank and automatic starting equipment. Sprinkler systems comprised a series of nozzles at ceiling level supplied with

pressurised water from a guaranteed supply. In the event of fire, heat opened the nozzles and allowed water to spray down over the affected area.

The mechanical services in buildings were normally controlled by local control panels located in various plant rooms throughout the building. This arrangement was quite satisfactory in buildings of reasonable size but in large units, particularly those with complex areas, an area might be served by a plant room some distance away and plant might be difficult to reach from outside the building.

Within each group of lifts provided to a building one should be designated as a fire lift. This lift should be supplied from an essential electrical circuit, ie a circuit separate from the normal lift supply and independent of the main isolating switch for the building. In a hospital such a lift should be large enough to accommodate a bed and capable of being controlled by the Fire Brigade with the operation of a key mechanism in the control panel.

To provide smoke free access for fire fighting, pressure ventilated staircases might be required. Basically such a system was an electric fan with distribution duct work through the staircase providing air at each landing, the fan being started automatically by the fire detection system or manually. The term 'pressurised ventilation' was perhaps a little misleading since this suggested that the pressure within the staircase would prevent smoke entry. This was not the case since prevention of smoke entry depended on a continuous outward flow of air away from the staircase.

DISCUSSION

In the course of the discussion sessions at both conferences the following were the main points to emerge:-

1 Evacuation of buildings

It was suggested with some reservations that in certain situations special areas with some degree of security might be set aside outside hospitals into which certain categories of long-stay patients might be easily moved or directed in the event of fire; this could for instance take the form of a walled garden. Types of equipment for use in evacuation were discussed. The technique of removing bedfast patients wrapped in mattresses was not particularly attractive although in units with low staffing ratios this method had often to be accepted. Bed mattress covers of man-made fibres were more satisfactory for moving patients in this way but were relatively expensive if provided on every bed - the number required could be limited by designating certain beds for the non-ambulant patients who would require to be physically moved from a ward area. In this event a plan of everyday patient location would have to be readily available in view of the high turnover rate of nursing staff. Man-made fibre slings could also be used to pull patients to safety but here again levels of staffing were important. In relation

to chutes the general feeling was expressed that these as envisaged at present were not satisfactory and presented additional hazards to safe evacuation. In response to a request for central guidance on the use of chutes in health buildings, it was indicated that their use was not likely to be encouraged except possibly in some instances where children or very ambulant cases were involved.

2 Staff education

The importance of educating all categories of staff to the real dangers which existed in buildings as to an outbreak of fire could not be over-emphasised. Undoubtedly a level of complacency existed and an "it will never happen to me" attitude was not uncommon. Regular training of staff in fire drill was important and the organisation of fire seminars, for instance, to discuss the management and leadership roles of medical and senior nursing staff and to see demonstrations of fire appliances and rescue procedures was helpful. The preparation of booklets on fire precautions for distribution to all personnel and instruction as a matter of routine to medical and nursing staff in training should also be encouraged.

3 Doors

The problem of locked doors and consequent difficulties in escape had arisen in many instances of major fires in buildings. A recent survey in a Scottish Region had indicated that some 1600 emergency exits or doors on routes to escape in hospitals were locked and of these only 600 were provided with an adjacent key. There was in many hospital situations no requirement for absolute security and it was the responsibility of authorities to look closely at the situation and ensure that doors were locked only when absolutely necessary. In circumstances where a key was provided this should be readily identifiable in an adjacent glass panel. To avoid fire and smoke spread, doors should ideally be kept closed but from the nursing viewpoint it was desirable to observe patients regularly and particularly at nights to hear any movement. This situation could present real problems in terms of fire spread. Fire resistant doors could be fitted with automatic closers wired into the fire alarm system which would normally hold the door open but allow it to close in the event of fire. This however was an expensive item and had to be provided with discretion. A lightweight fire resistant door with internal honeycomb had also recently been devised and this had some attractive qualities.

4 Fire certificates

It was probable that a Designating Order in respect of hospitals would be issued in due course under the Fire Precautions Act 1971. This would make the issuing of a Fire Certificate essential in respect of hospital property. A Code was in course of preparation and would be issued for guidance. Since hospitals were Crown property, it was likely that certificates would be issed by Her Majesty's Inspectorate of Fire Services although the examination of premises could be delegated to the appropriate Fire

Brigade. It was pointed out that hospitals being complex buildings and of varying ages, there was now a need for authorities to consider areas which were likely to require the earliest attention and to review the responsibilities of their officers in fire related matters.

5 Fire ratings of materials

In view of the variety of materials which were available for use in buildings, the value of a list of fire ratings of items such as paints and a wide range of plastics in use was discussed. This was applicable to numerous items and combinations of materials and although the Fire Research Station could supply information on the qualities of the more commonly used items, with the ever increasing range of materials available, many products and composites undoubtedly required further investigation as to their fire qualities. This was particularly important in hospital wards where patients were more vulnerable to the toxic effects of smoke.

6 Fire alarms and detectors

Different types of fire alarm systems were available and their suitability depended on the type of unit into which they were to be installed. Telephone systems, although still in use in many situations, presented difficulties in relation to dialling confusion in the darkness or smoke, jamming of lines and could frequently be the object of misuse and vandalism. The provision of a suitable fire alarm system in each area was a more satisfactory arrangement and use of the telephone could then be restricted solely for transmitting the source of the alarm. The provision of heat/smoke detectors was not generally felt to be necessary in areas where continual activity took place but should be installed in office-type situations where areas were left unused for lengthy periods.

7 Lifts

Different opinions existed as to the use of lifts for evacuation purposes in the case of an outbreak of fire. Many Fire Service officers mainly due to several fatalities which had occurred, were not in favour of their use, although it was mentioned that with the complexity of health buildings every possible form of escape should be utilised. In a multi-fire zone building, if lifts were situated in a zone not affected by the fire, it was suggested that they could be used for the evacuation of ambulant patients provided that they were powered from a source outside the zone of the fire. Reservations were however expressed on the movement of bedfast patients by lifts. By and large lift systems in most hospitals and other buildings were not adequately designed to carry out this function since it was necessary that enclosed hallways should be provided at lift entrances and other special power and protection facilities provided.

Scottish Hospital Centre
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